

Attorney's Docket No.: 006405.P005

Patent

UNITED STATES PATENT APPLICATION

For

TERMINATING FRAME RECEPTION

Inventor:

Michael John Vidion Moreton

Prepared by:

BLAKELY, SOKOLOFF, TAYLOR & ZAFMAN, LLP  
12400 WILSHIRE BOULEVARD  
SEVENTH FLOOR  
LOS ANGELES, CALIFORNIA 90025-1026  
(408) 720-8300

Attorney Docket No.: 006405.P005

---

"Express Mail" mailing label number: EV 336589321 US

Date of Deposit: December 4, 2003

I hereby certify that I am causing this paper or fee to be deposited with the United States Postal Service "Express Mail Post Office to Addressee" service on the date indicated above and that this paper or fee has been addressed to Mail Stop Patent Application, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

Linda K. Brost

(Typed or printed name of person mailing paper or fee)

Linda K. Brost

(Signature of person mailing paper or fee)

December 4, 2003

(Date signed)

## TERMINATING FRAME RECEPTION

### Field of the Invention

- 5 The present invention relates to wireless Local Area Networks (WLANs) and in particular to a method of processing a data frame at a node in a wireless Local Area Network.

### Background of the Invention

10

- Wireless networks, as standardised by the Institute of Electrical and Electronics Engineers (IEEE) in their document 802.11, consist of a number of nodes that transmit units of data called frames on a shared radio channel. Only one node can transmit at once and the allocation of the channel to an individual node, so that it can transmit a frame, is handled by an algorithm specified by the standard.

- Each frame consists of header information, optionally followed in time by a payload. The payload is the data which the network was designed to transport from node to node. The header contains the frame type (which describes the frame's role in the protocol), information about the length of the frame, an address field that identifies the intended recipient(s) of the frame and other information required for the correct operation of the protocol.

25

- Stations in an IEEE 802.11 wireless network have hardware for the transmission and reception of the radio signals specified by the standard. This hardware can, in general, only be used on a single radio channel at once. In addition, most hardware of this type has the facility to be switched off when not in use, in a process substantially reducing the power consumption. As wireless LANs are often used in battery

30

powered devices, any mechanism for reducing power consumption is extremely desirable.

It is accordingly an object of the present invention to address such  
5 power consumption issues.

### Summary of the Invention

In accordance with the present invention there is provided a method of  
10 processing a data frame at a node in a wireless Local Area Network,  
the method comprising receiving a first part of a transmitted frame,  
identifying within that first part of the transmitted frame, a frame  
destination address and terminating reception of a second part of the  
transmitted frame when it is determined that the frame destination  
15 address indicates that the transmitted frame is not intended for that  
node.

There is also provided a wireless Local Area Network access node  
comprising a receiver adapted to receive a first part of a transmitted  
20 frame within the wireless Local Area Network, a processor means  
configured to detect the frame destination address from the first part of  
the transmitted frame, and terminate reception of the second part of the  
frame when it is determined that the frame destination address  
indicates that the transmitted frame is not intended for that node.

25

In some embodiments the frame destination address may indicate an individual node. In additional or alternative embodiments the frame destination address may indicate all nodes or a group of nodes.

30 A technique is accordingly proposed by which a node can determine at an early stage that the rest of the frame is of no interest to it. This frees

a period of time during which the receiver hardware can either be placed into a low power consumption mode, or during which it could be used for other purposes. Examples of such other purposes include scanning alternative radio channels for alternative wireless networks that the node might wish to use at some later point, and detecting the presence of other users of the radio channel, such as radar.

IEEE 802.11 already includes a mechanism for nodes to enter a power saving state. While in this state, the node will neither transmit nor receive frames, and other nodes in the network will store frames intended for that node until it wakes up from the power saving state.

The amount of co-ordination required between the nodes in the network to achieve this means that it works on a fairly coarse granularity (of the order of 100 milliseconds). This means that performance of the network connection will be disrupted for the node in question. Higher level protocols that are encapsulated inside the frames (such as TCP/IP) may react badly to the stop/start nature of the link, potentially reducing the overall performance even further. As a result the standard power saving state should only be used at times when the traffic requirements of the node in question are extremely low, or the reduction in performance is unlikely to be noticeable to the user of the device.

In contrast, the mechanism described below does not require any co-operation from other nodes in the network, and does not disrupt the normal flow of frames in any way. The only time used is time that would normally be wasted in the reception of data that would immediately be discarded.

In a particularly preferred embodiment, the first part of the transmitted frame further includes a transmission duration indicator which indicates

the expected duration of exchange of information related to the transmitted frame, after the transmission thereof. In that case, preferably, the method further comprises terminating reception of the said second part of the transmitted frame only when the transmission  
5 duration indicator indicates that the said expected duration of transmission is less than a predetermined threshold.

Further preferred features are set out in the dependent claims appended hereto.

10

According to a still further aspect of the invention, there is provided a method of processing a data frame at a node in a wireless Local Area Network, the method comprising:

- receiving a first part of a transmitted frame;
- 15 identifying, within that first part of the transmitted frame, a frame destination address;
- identifying, within the first part of the transmitted frame, a duration field, indicative of an expected duration of exchange of information related to the transmitted frame, after the transmission  
20 thereof; and,
- terminating reception of a second part of the transmitted frame when it is determined that the frame destination address indicates that the transmitted frame is not intended for that node and the duration field indicates the duration of exchange of information is less than a  
25 predetermined time.

It will be understood by those skilled in the art that the dependent claims could equally be applied to this aspect as well.

### Brief description of the drawings

The present invention may be put into practise in a number of ways, and some embodiments will now be described by way of example only  
5 and with reference to the accompanying drawings, in which:

Figure 1 shows a schematic diagram illustrating the constituent parts of a typical transmitted frame in a wireless Local Area Network; and

10 Figure 2 shows, again schematically, a pair of the frames in figure 1, separated by an acknowledgement frame and some time gaps.

### Detailed description of preferred embodiments

15 The generalised format of an IEEE 802.11 frame is shown in figure 1. Elements of the frame are transmitted one after the other (in time) starting at the left of the frame, and continuing (without break) to the right.

20 The elements of the frame that are useful in this invention are:

The Physical Layer Convergence Procedure (PLCP) header which contains the PLCP Length field, and can be used to determine the period of time until the end of the frame; the MAC header, which  
25 contains the frame destination address, a frame duration field, which indicates the expected time to complete frame exchange after transmission of the present frame, as well as the frame type, and the frame type; and the Frame Check Sequence (FCS), which allows the receiving node to discard frames that have been corrupted by  
30 interference.

If the destination address field in the MAC header does not specify the receiving node, then the receiving node knows that the payload (if any) is of no interest to it. Furthermore, it also knows that the FCS will not  
5 be of interest to it either, as all it can indicate is another reason for ignoring the rest of the frame.

Hence the node knows that there will be a period of time (that can be calculated from the PLCP header length field) during which the radio  
10 medium will be busy with data that is of no interest to this node. It can use this period of time to perform other tasks such as:

- (a) entering a low power consumption mode,
- (b) tuning to a different radio channel and looking for other wireless LANs that it might want to connect to at some later  
15 point,
- (c) or performing checks for other users of the current channel, such as the radar detection checks required in some regulatory domains.

20 However, as a condition to accessing the medium, the MAC Layer in a node must first check the value of its Network Allocation Vector (NAV), which is a counter resident at each node that represents the amount of time that the post-frame information exchange for the previous frame will take to send. The NAV counter must be zero before that node is  
25 allowed to access the shared medium and attempt to send a frame. In this way, collisions are avoided.

Prior to transmitting a frame, a node calculates the expected time to complete frame exchange after transmission of the present frame. For  
30 example, following a "normal" data frame, there is a Short Inter Frame Space (SIFS), and then an ACK frame is sent which requests

acknowledgement of receipt of the data frame preceding that ACK frame. The node then places a value representing this time in the duration field of the MAC header. For a broadcast frame, the duration field is thus zero, since broadcast frames are not acknowledged. When  
 5 stations receive a data frame with a header, they examine this duration field value and use it as the basis for setting their corresponding NAVs.

The duration field can indicate that the post data frame information exchange for the frame to be sent will take a relatively long time or only  
 10 a short time. However, in some cases, the duration field can be corrupted from being a short value to being a long value instead. The receiving node can only tell the duration field has been corrupted if the whole frame is received and the checksum is invalid.

15 To ensure that the node will not remain idle for a period longer than required, in a further enhancement, the node will only use the duration field if it indicates that the post data frame information exchange period will be small. If the duration field indicates a large value, (for example, a time greater than a SIFS plus an ACK frame) then the node will  
 20 automatically continue to receive the whole of the frame including the FCS to check the duration field is valid, then set the NAV and node idle time accordingly.

An even further enhancement is possible and is described in figure 2.  
 25 The protocol defines that after transmission of a frame with a payload there will be a short delay (B) (the SIFS mentioned above), followed by transmission of an ACK frame, followed by another short period (C), which will be at least as long as a SIFS. As the time taken to transmit the ACK frame can be calculated, the time period during which this  
 30 node can be idle (D), and therefore ignore frames on the channel, is



extended by an additional period of  $2 \times \text{SIFS}$  plus the time to send the ACK.

- 5 The major advantage of this invention is that it can be used even during periods of relatively heavy traffic on the radio channel, and is invisible to transported protocols, and hence the user. Moreover, the present invention is applicable to ad hoc mode and infrastructure modes of wireless network communications.
- 10 Whilst embodiments of the invention are described in terms of 802.11x standards, it would be understood by a person skilled in the art that the invention could be applied to other wireless local area network technologies, such as (but not limited to) Bluetooth.